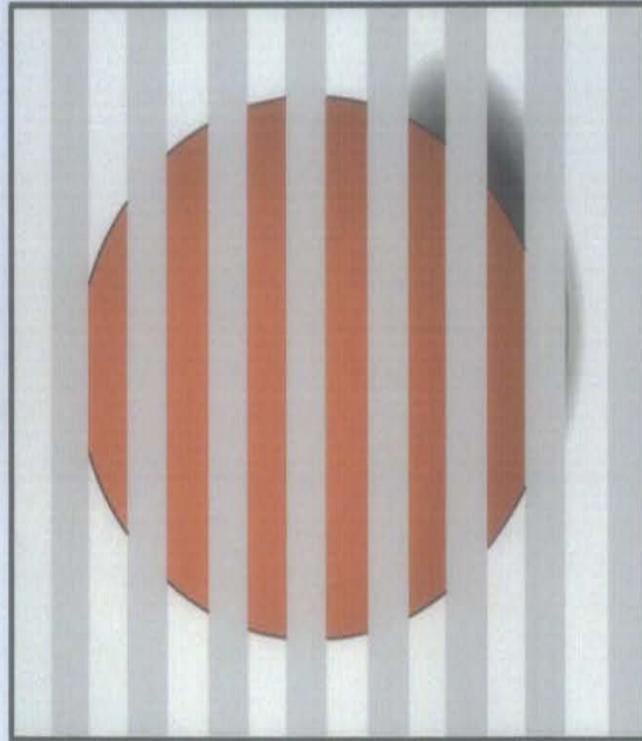


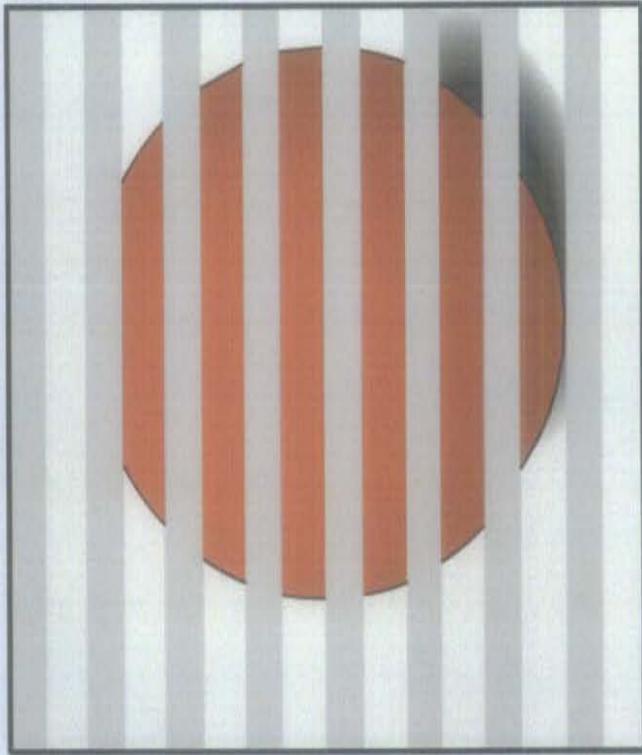
## Coding Interlaced Video As Interlaced Frames Presented Problems

The Bottom Field is captured 1/60<sup>th</sup> of a second after the Top Field

Top Field

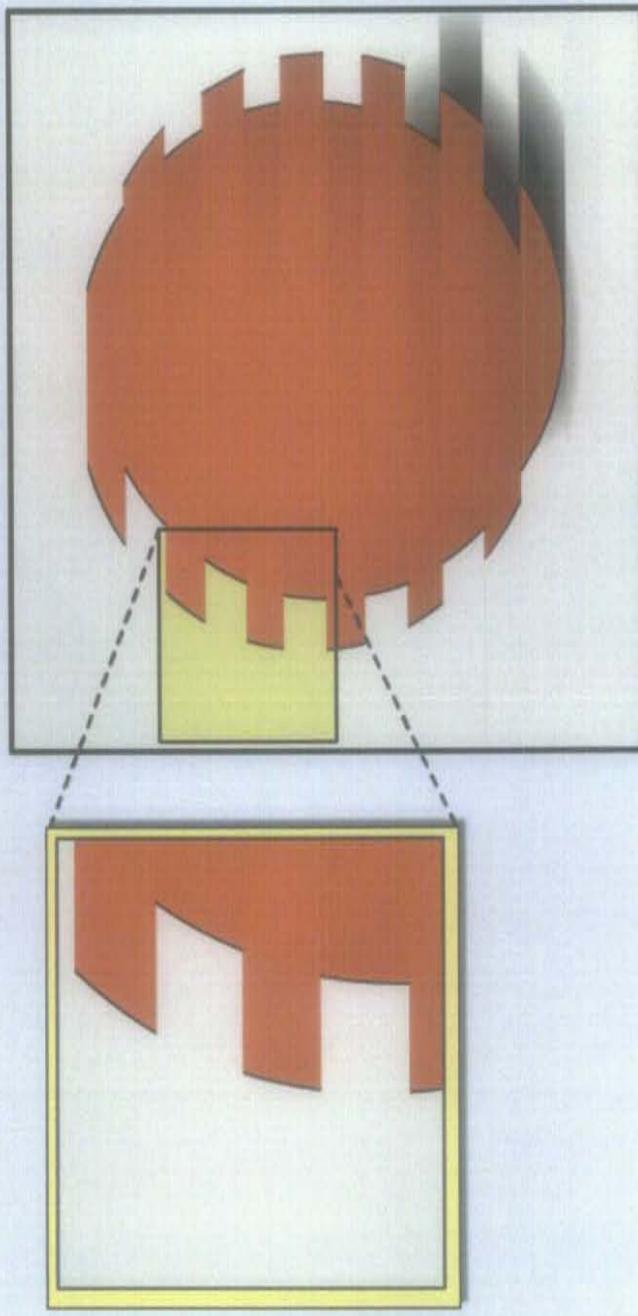


Bottom Field



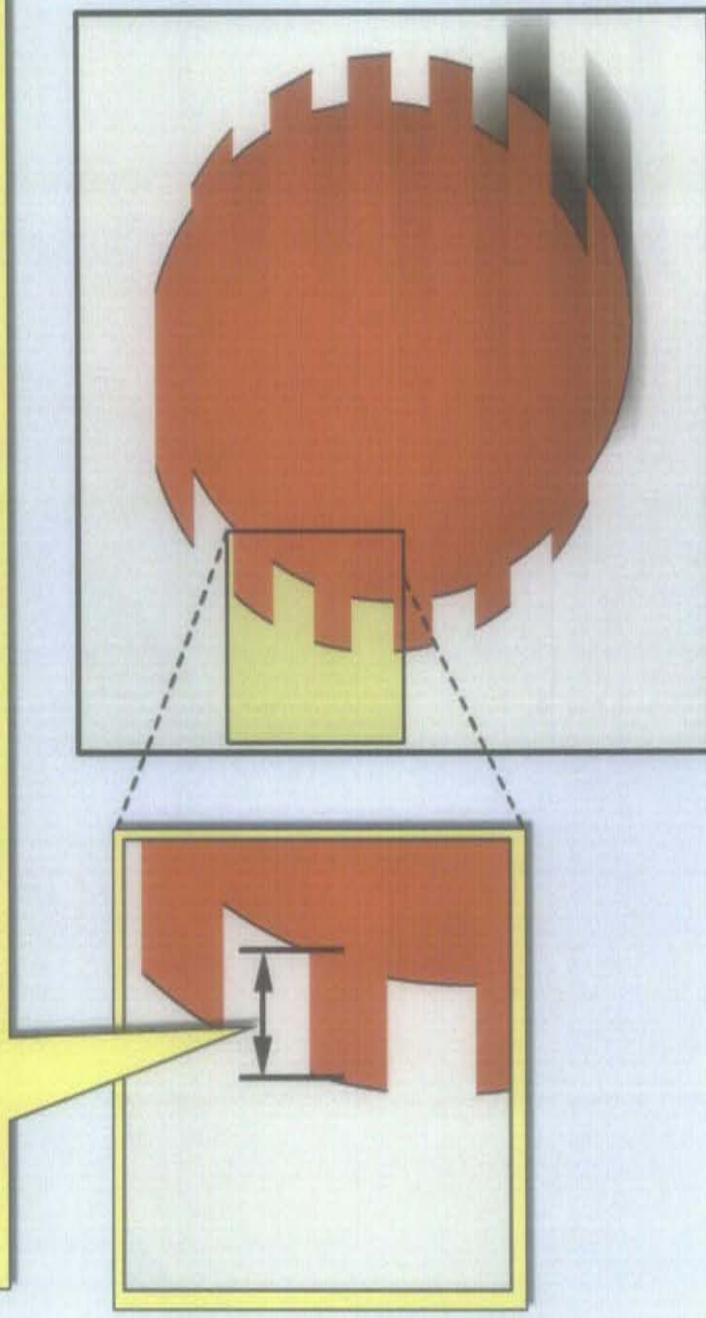
## Coding Interlaced Video As Interlaced Frames Presented Problems

In FRAME MODE, the two fields are combined.  
When two fields are combined, a "combing" effect occurs



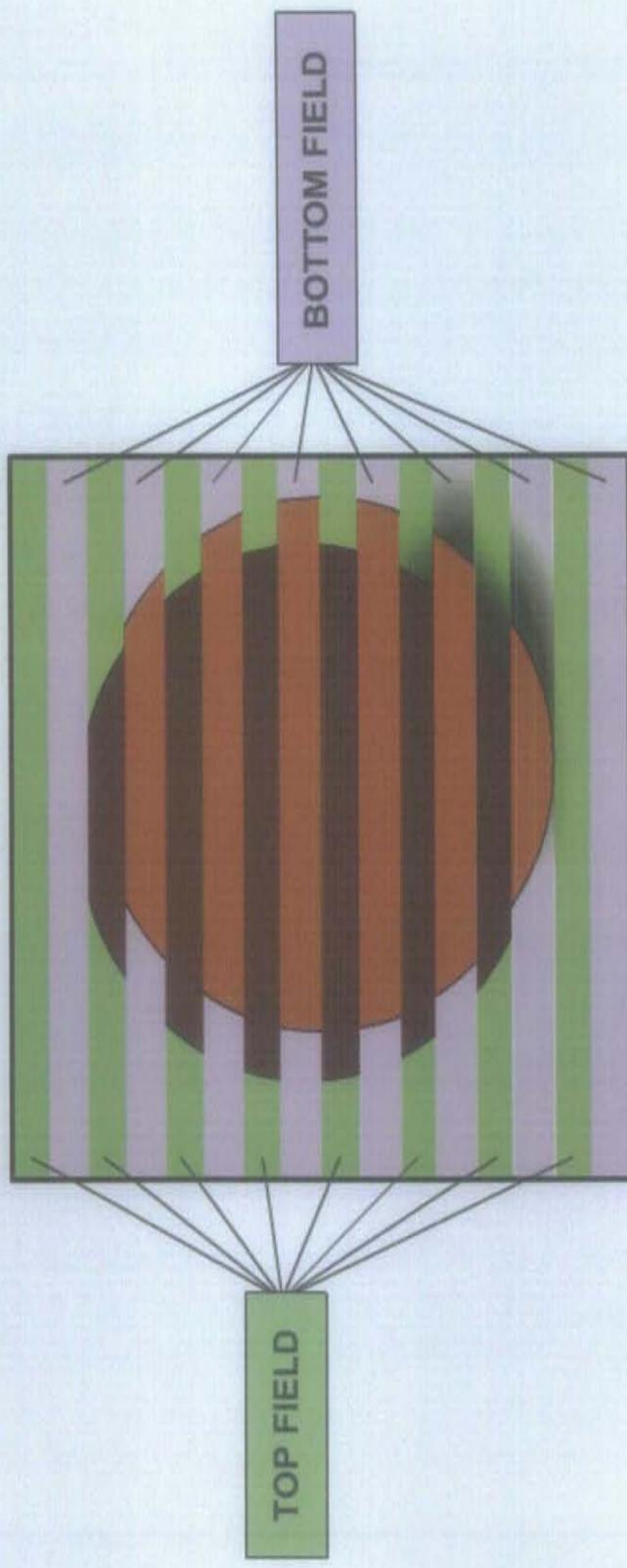
## Coding Interlaced Video As Interlaced Frames Presented Problems

The jagged edge is caused by the motion of the ball and the delay in capturing the second field. The ball moves this much from one field to the next (1/60th of a second).



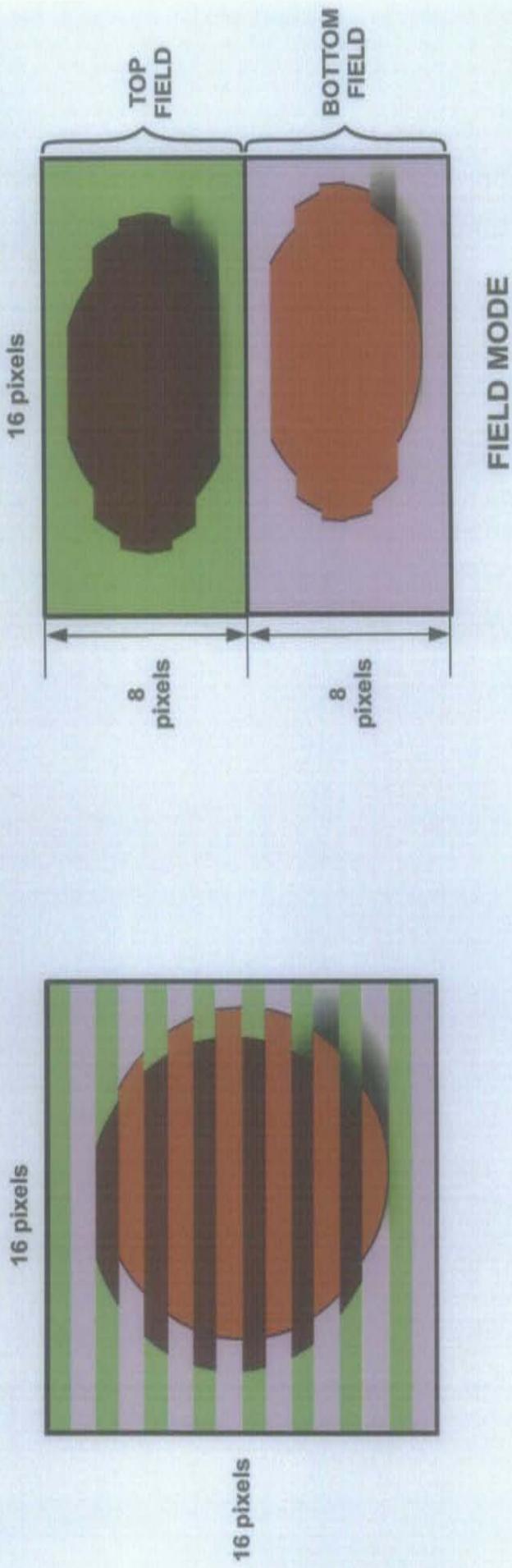
## AFF Coding On Single Macroblocks Presented Problems

In FRAME MODE, the two fields are coded jointly. The "combing" effect results in less efficient compression.



## AFF Coding On Single Macroblocks Presented Problems

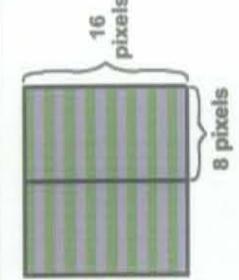
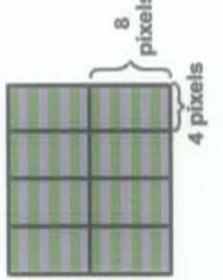
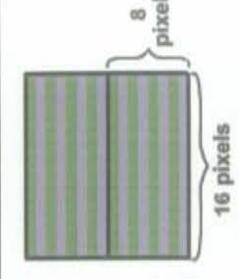
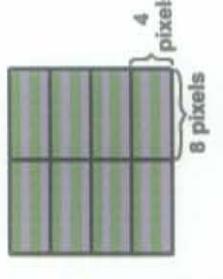
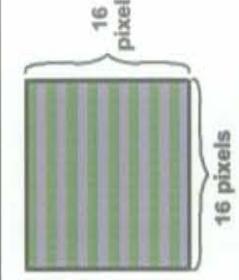
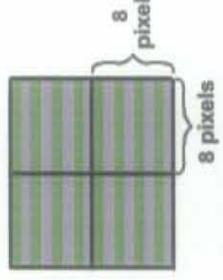
In FIELD MODE encoding, a macroblock is split into a TOP FIELD and a BOTTOM FIELD. The two fields are then encoded separately. This results in more efficient compression.



## AFF Coding On Single Macroblocks Presented Problems

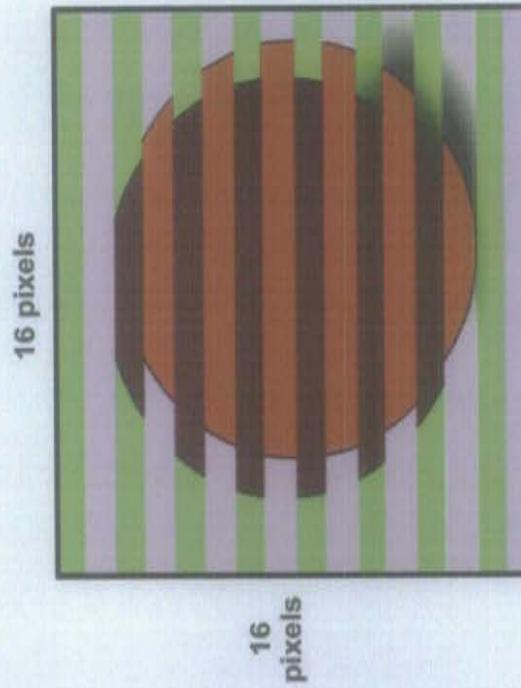
In FRAME MODE, the macroblock can be divided into seven different block sizes

Macroblock Division Options

Once encoded as a frame, the macroblock can be further divided into the smaller blocks of FIGS. 3a-f for use in temporal prediction with motion compensation algorithm.

'374 Patent, 7:1-3



FRAME MODE



Index



FRAME  
1110



SLIDE  
6



## AFF Coding On Single Macroblocks Presented Problems

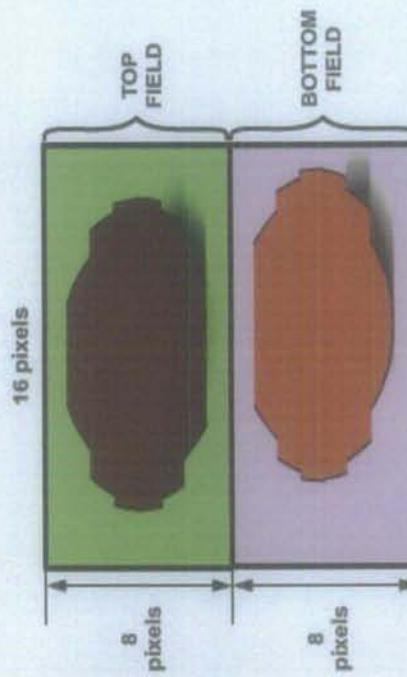
**In FIELD MODE, the macroblock can be divided into only five different block sizes because a single block cannot comprise both top and bottom fields. Prediction performance suffers.**

Macroblock Division Options

<p>16 pixels 8 pixels 8 pixels</p>	<p>16 pixels 8 pixels 8 pixels 4 pixels 8 pixels 8 pixels 4 pixels</p>	
<p>16 pixels 8 pixels 8 pixels 4 pixels 8 pixels 8 pixels 4 pixels</p>	<p>16 pixels 8 pixels 8 pixels 4 pixels 8 pixels 8 pixels 4 pixels</p>	

"The block sizes of 16 by 16 pixels, 8 by 16 pixels ... are not available for a macroblock encoded in field mode because of the single parity requirement. This implies that the performance of single macroblock based AFF may not be good for some sequences or applications that strongly favor field mode coding."

'374 Patent, 7:32-37

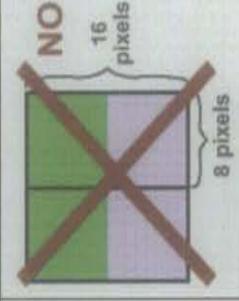
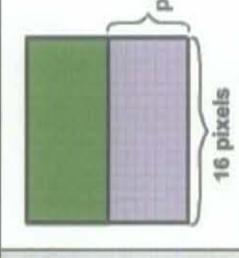
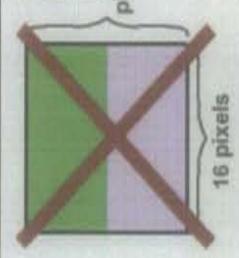
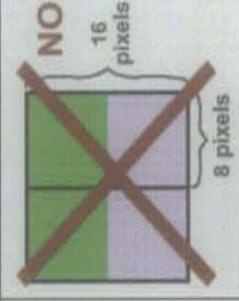
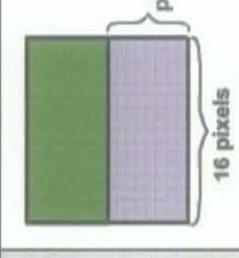
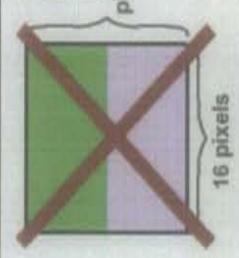
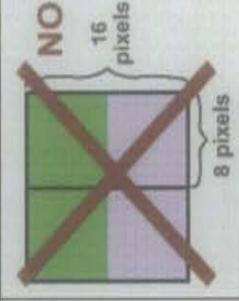
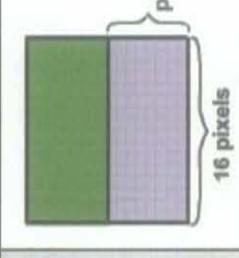
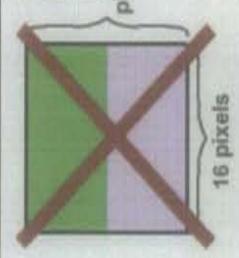


FIELD MODE

## AFF Coding On Single Macroblocks Presented Problems

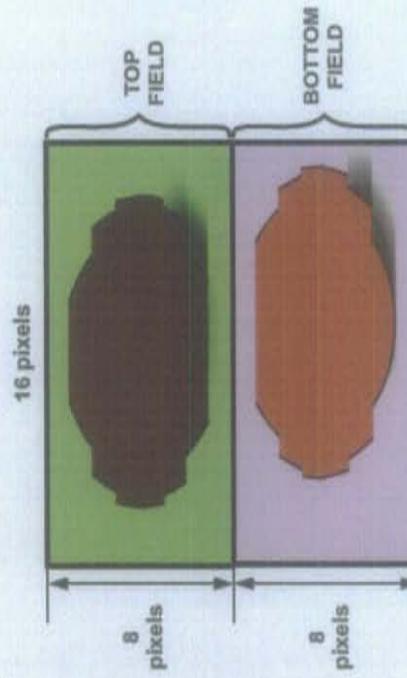
**The problem: How to code objects in motion most efficiently by getting the benefits of FIELD CODING and the flexibility of all 7 block sizes.**

Macroblock Division Options

"The block sizes of 16 by 16 pixels, 8 by 16 pixels ... are not available for a macroblock encoded in field mode because of the single parity requirement. This implies that the performance of single macroblock based AFF may not be good for some sequences or applications that strongly favor field mode coding."

'374 Patent, 7:32-37



FIELD MODE

FRAME  
1112

SLIDE  
6

UP  
DOWN

Index

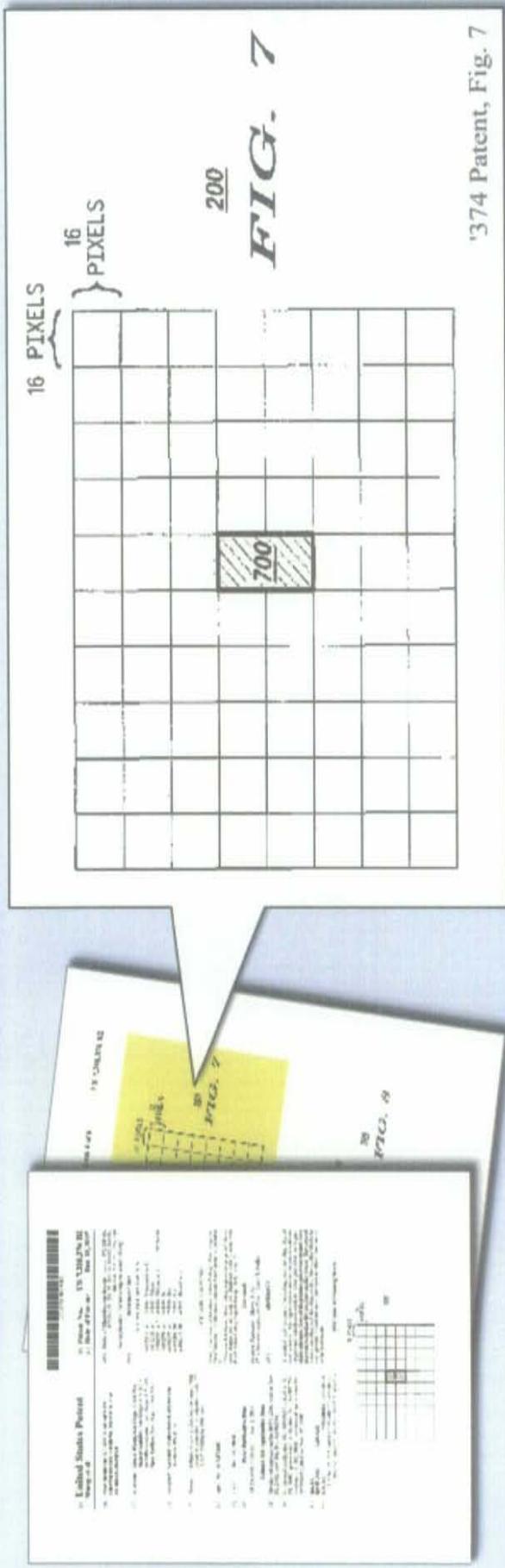
X

## AFF Coding On Pairs Of Macroblocks Solved Those Problems

**The solution: One embodiment of the claimed invention is to perform coding on macroblock pairs instead of on a single macroblock. This allows for all the same options of macroblock subdivisions for both FRAME MODE and FIELD MODE.**

"In order to guarantee the performance of field mode macroblock coding , it is preferable in some applications for macroblocks that are coded in field mode to have the same block sizes as macroblocks that are code in frame mode. This can be achieved by performing AFF coding on macroblock pairs instead of on single macroblocks."

'374 Patent, 7:37-43



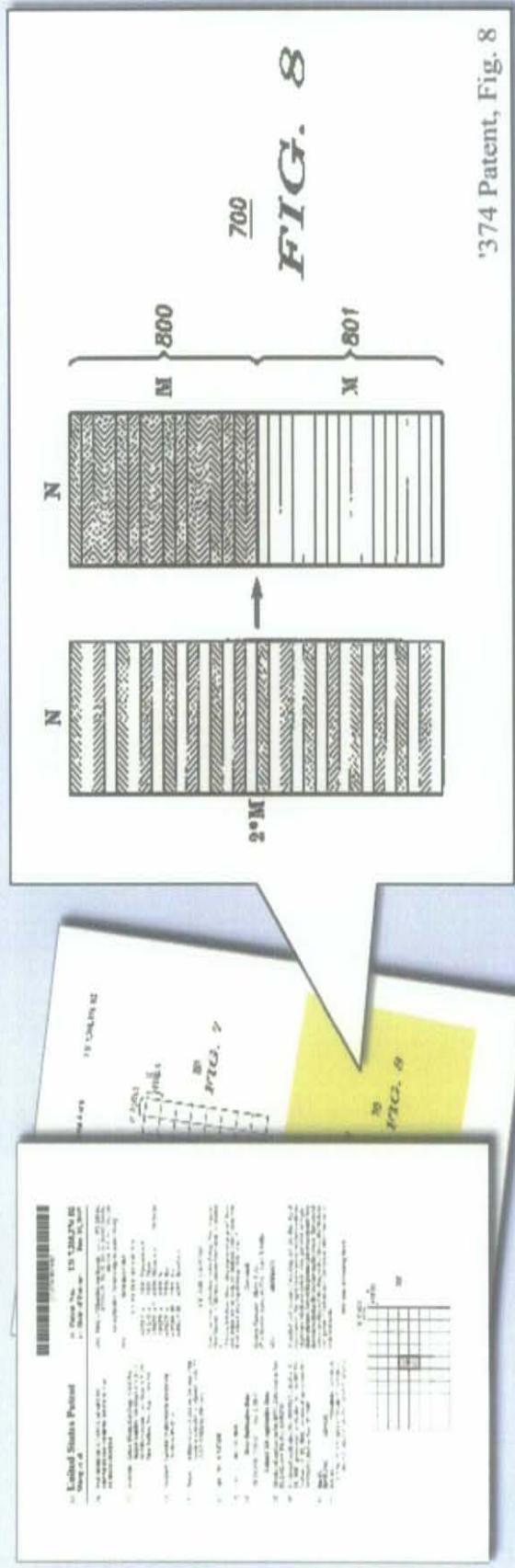
'374 Patent, Fig. 7

## AFF Coding On Pairs Of Macroblocks Solved Those Problems

**The solution: One embodiment of the claimed invention is to perform coding on macroblock pairs instead of on a single macroblock. This allows for all the same options of macroblock subdivisions for both FRAME MODE and FIELD MODE.**

"In order to guarantee the performance of field mode macroblock coding , it is preferable in some applications for macroblocks that are coded in field mode to have the same block sizes as macroblocks that are code in frame mode. This can be achieved by performing AFF coding on macroblock pairs instead of on single macroblocks."

'374 Patent, 7:37-43

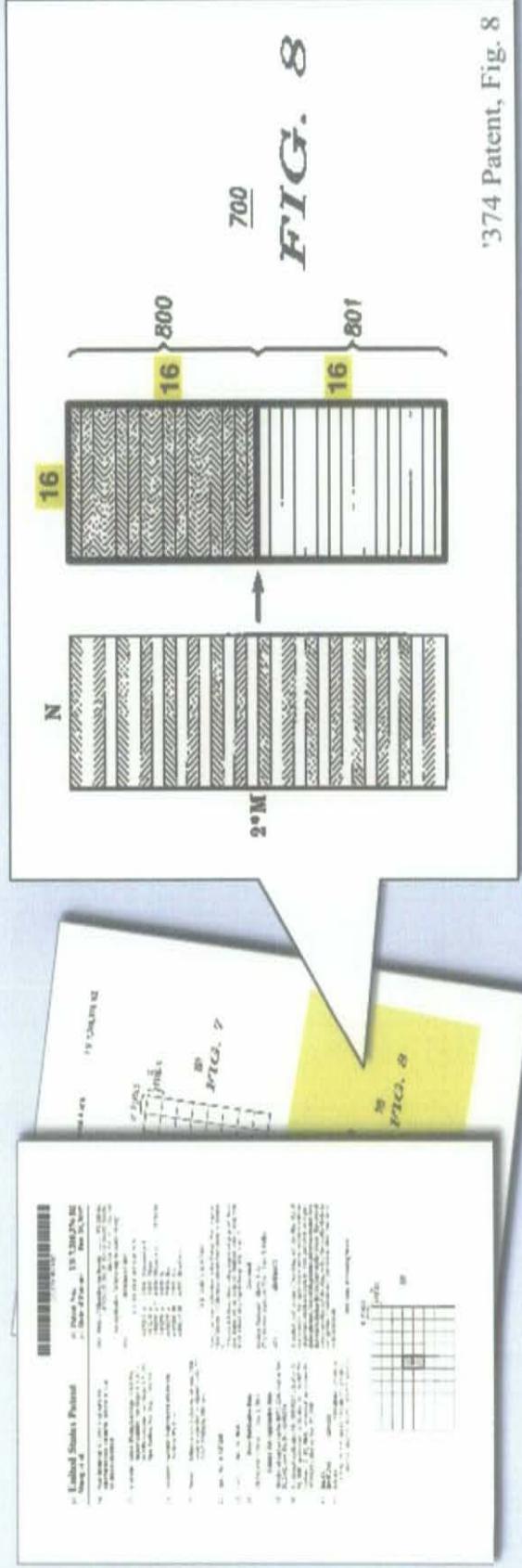


## AFF Coding On Pairs Of Macroblocks Solved Those Problems

**The solution: One embodiment of the claimed invention is to perform coding on macroblock pairs instead of on a single macroblock. This allows for all the same options of macroblock subdivisions for both FRAME MODE and FIELD MODE.**

"In FIG. 8, each macroblock in the pair of macroblocks (700) has N=16 columns of pixels and M=16 rows of pixels. Thus, the dimensions of the pair of macroblocks (700) is 16 by 32 pixels."

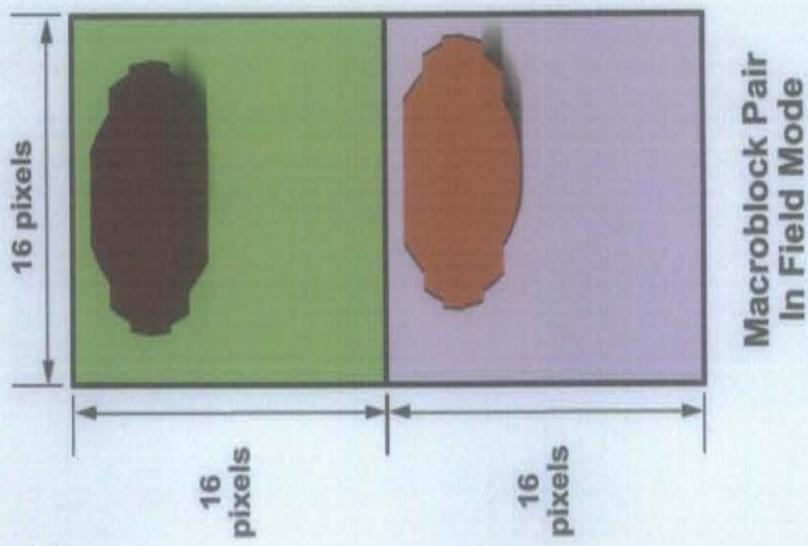
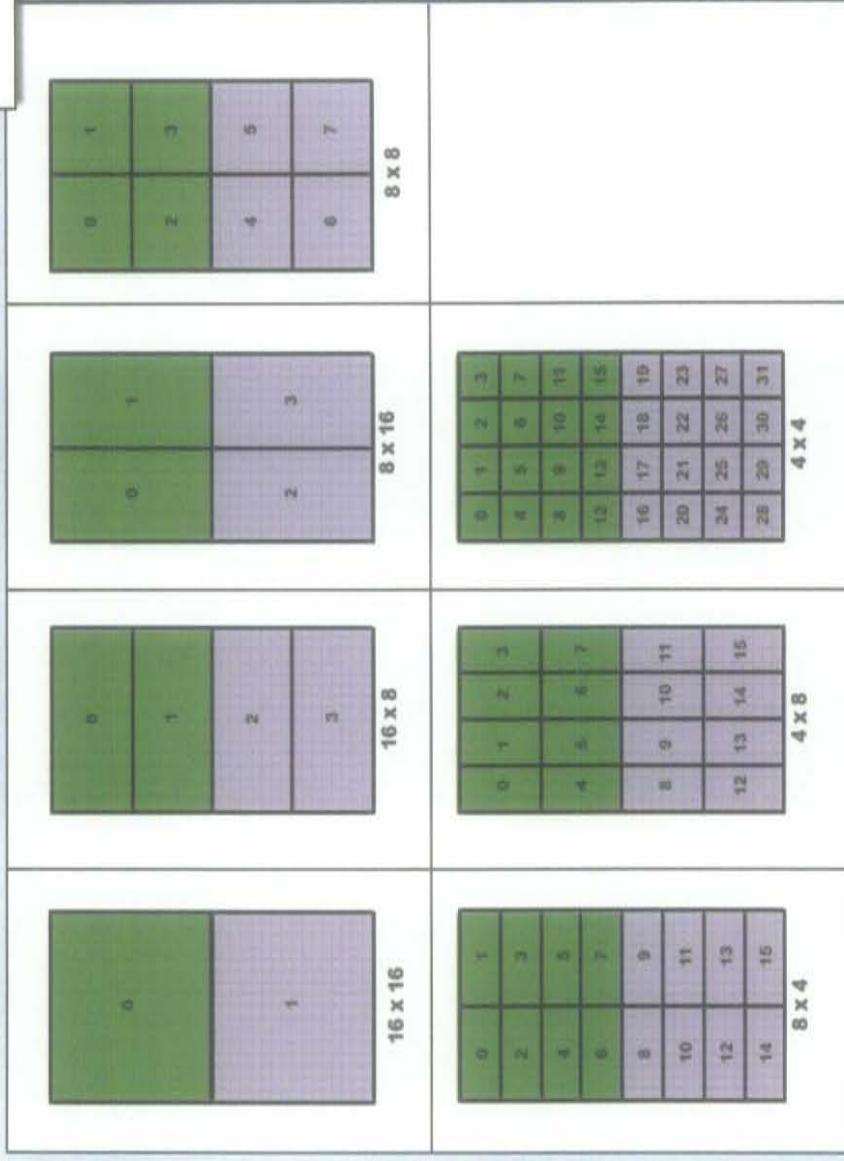
'374 Patent, 7:58-61



## AFF Coding On Pairs Of Macroblocks Solved Those Problems

**With Motorola's invention, all 7 block size options are available in FIELD MODE.**

The top field block (800) and the bottom field block (801) can now be divided into one of the possible block sizes of FIGS. 3a-f.  
'374 Patent, 7:65-67



ECF No. 160-2, Ex. K, Fig. 17

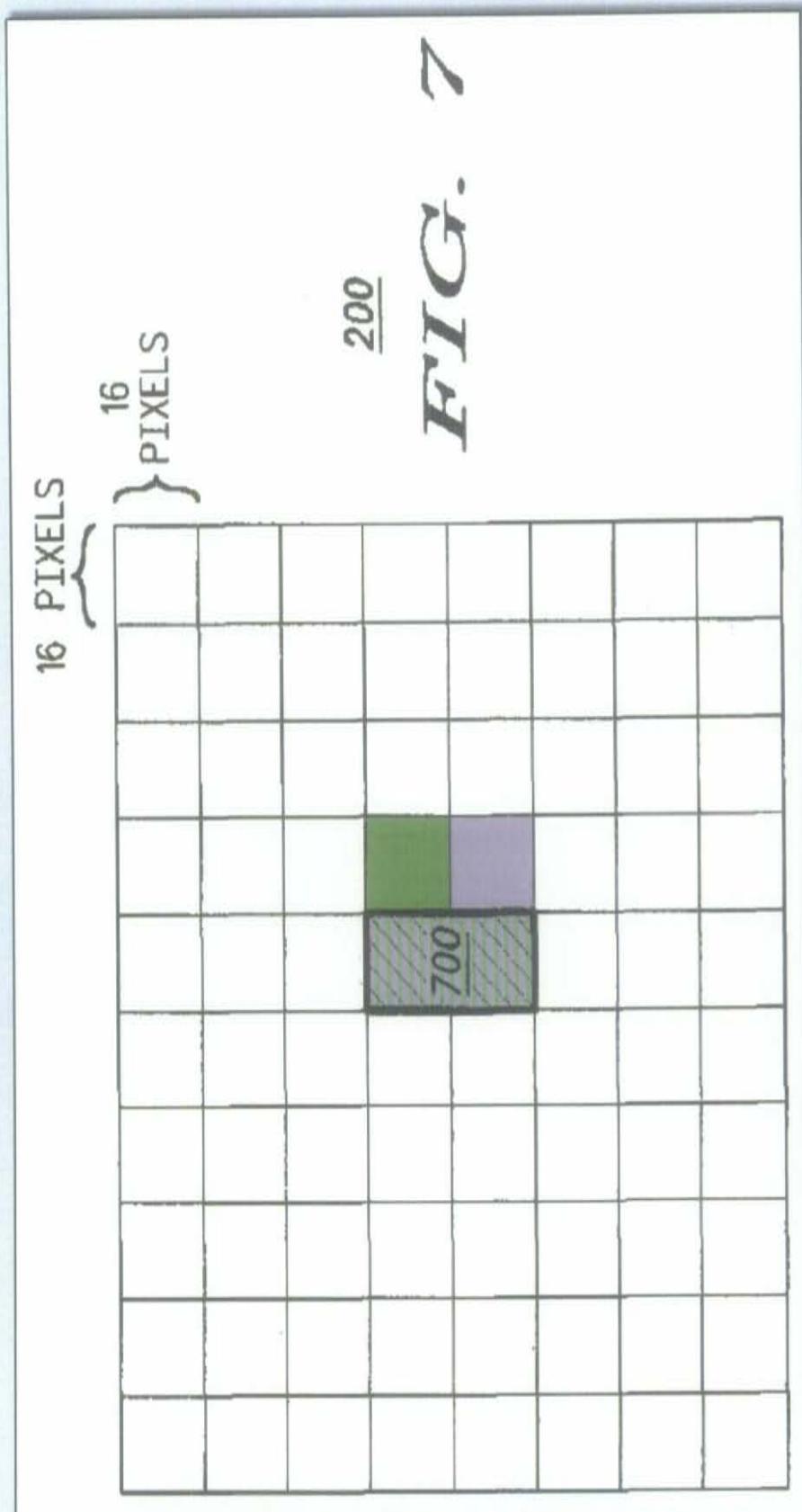
SLIDE  
6

FRAME  
1408

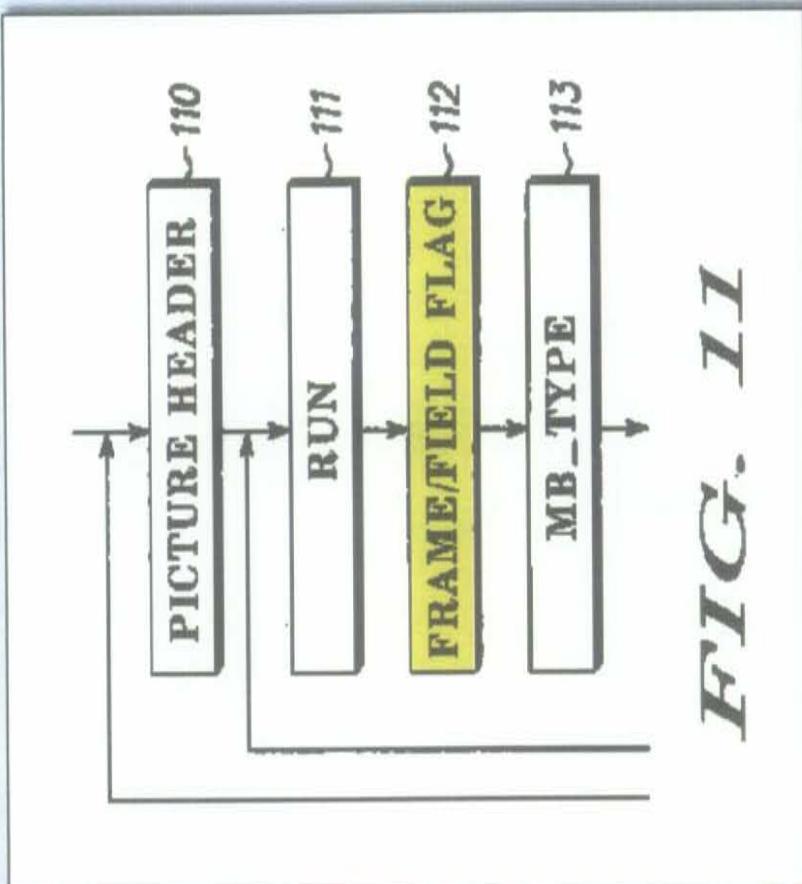
Index

X

## AFF Coding On Pairs Of Macroblocks Solved Those Problems



## Frame/Field Flag Indicates Which Mode, Frame Or Field, Is Used In Coding



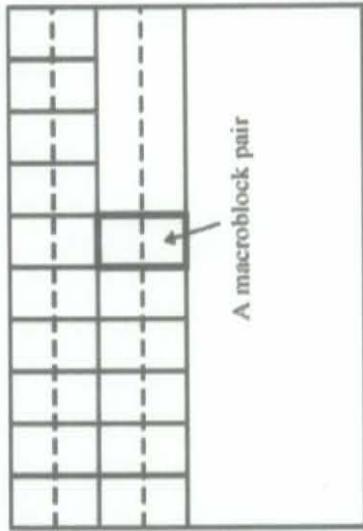
In AFF coding at the macroblock level, a frame/field flag bit is preferably included in a picture's bitstream to indicate which mode, frame mode or field mode, is used in the encoding of each macroblock. The bitstream includes information pertinent to each macroblock within a stream, as shown in FIG. 11. If the AFF is performed on pairs of macroblocks, the frame/field flag (112) is preferably included before each pair of macroblock in the bitstream.

'374 Patent, 8:46-58

**FIG. 11**

## Motorola's macroblock adaptive frame/field (MBAFF) coding invention was adopted into the H.264 Standard

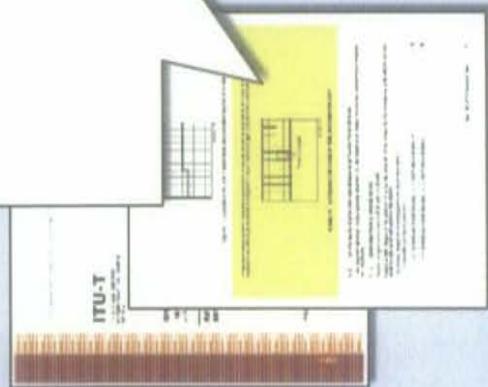
When macroblock-adaptive frame/field decoding is in use, the picture is partitioned into slices containing an integer number of macroblock pairs as shown in Figure 6-8. Each macroblock pair consists of two macroblocks.



H.264(00)\_F6-8

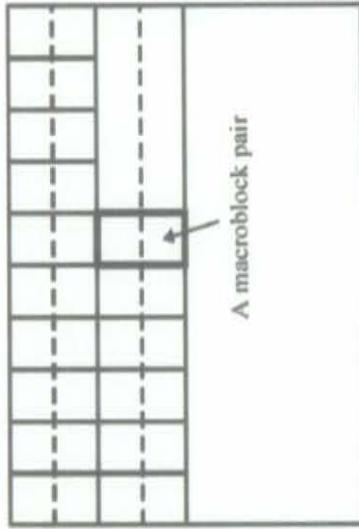
**Figure 6-8 – Partitioning of the decoded frame into macroblock pairs**

Dkt. 163-1, Ex. X, H.264 Standard, p.25



## Motorola's macroblock adaptive frame/field (MBAFF) coding invention was adopted into the H.264 Standard

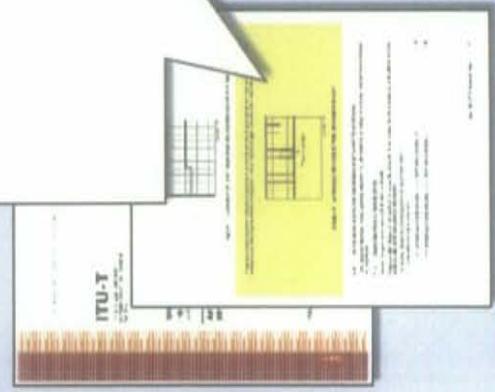
When macroblock-adaptive frame/field decoding is in use, the picture is partitioned into slices containing an integer number of macroblock pairs as shown in Figure 6-8. Each macroblock pair consists of two macroblocks.



H.264[09].\_F6-8

Figure 6-8 – Partitioning of the decoded frame into macroblock pairs

Dkt. 163-1, Ex. X, H.264 Standard, p.25



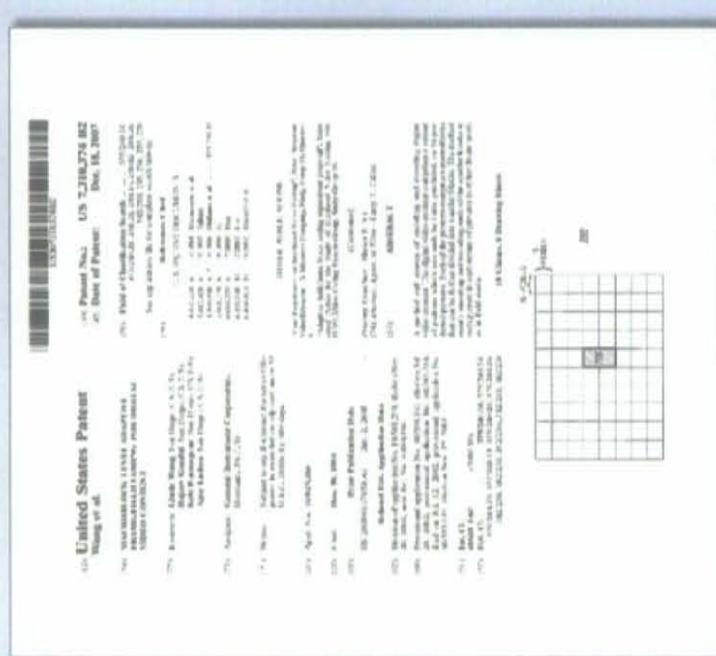
## The '374, '375 and '376 Patents

**The Asserted Patents are directed to Motorola's  
MBAFF Invention together with:**

- Inter coding ('374)
- Intra coding ('375)
- Scanning Paths ('376)

## The '374 Patent Claims Are Directed To The MBAFF Invention Together With Inter Coding

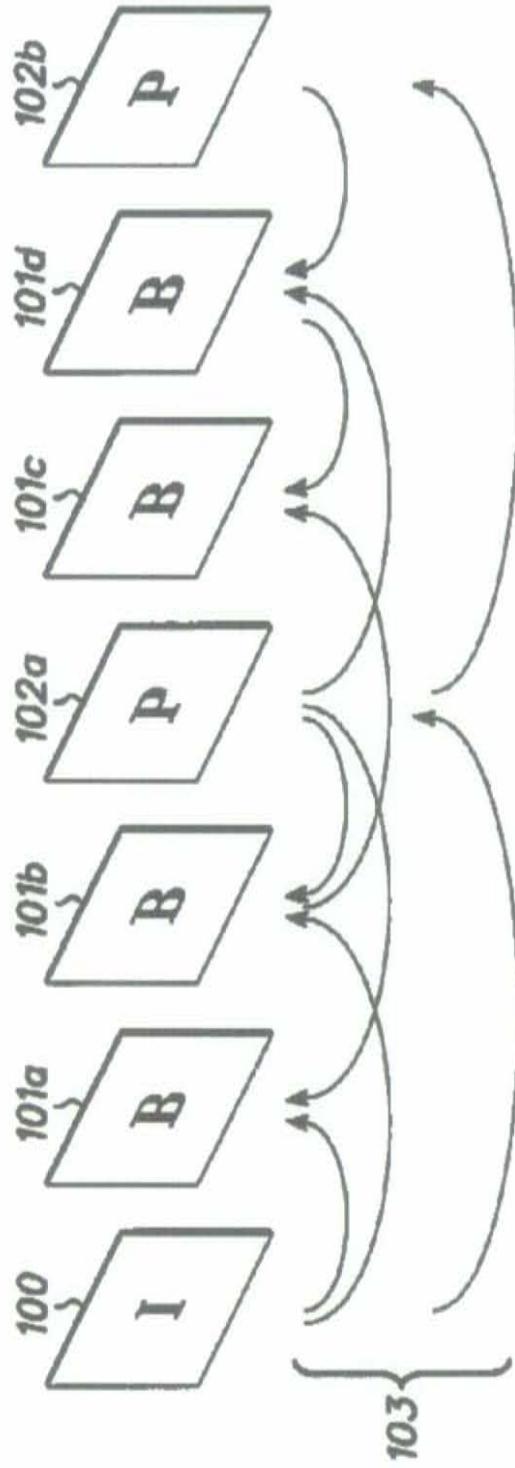
**Inter coding is coding a picture by referring to reference pictures (i.e., pictures earlier or later in time) in order to predict the values of a block of pixels.**



## Inter Coding: Encoding A Macroblock In A Predicted Picture By Referring To A Similar Macroblock In A Reference Picture

A predicted picture (102a, b) is encoded using an I, P, or B picture that has already been encoded as a reference picture.

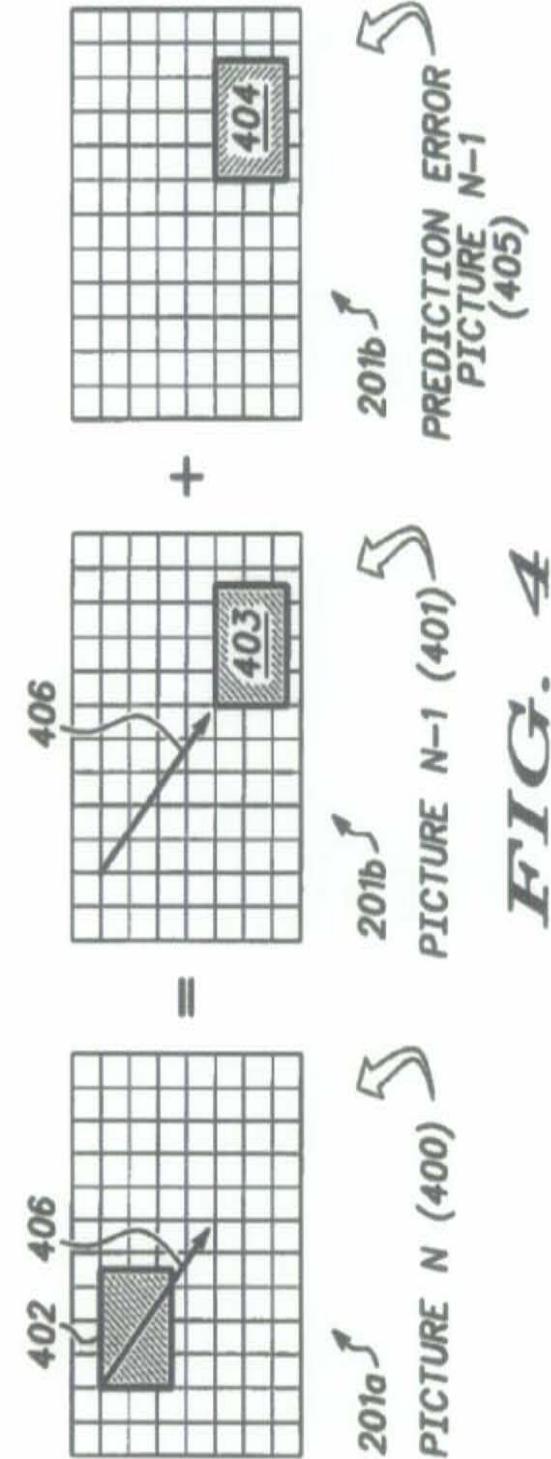
'374 Patent, 5:16-18



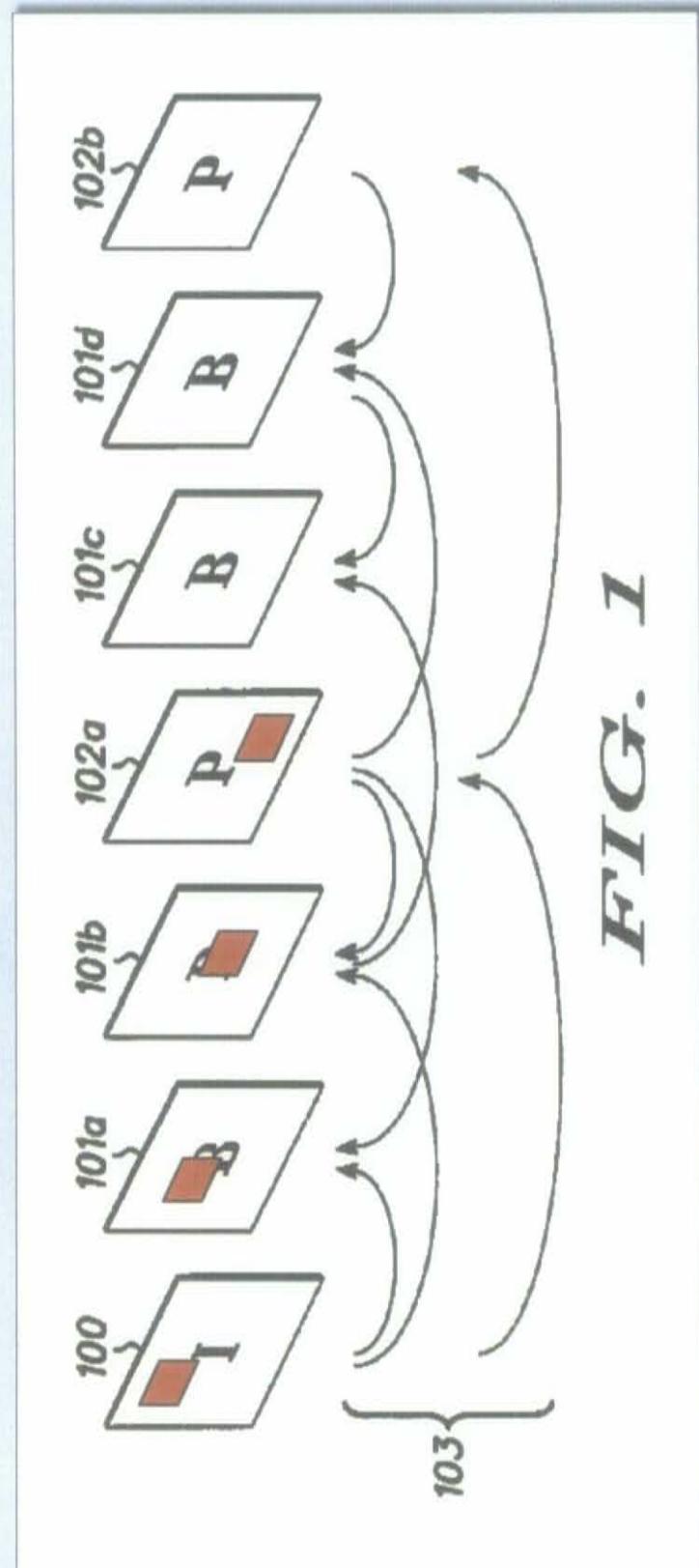
**FIG. 1**

## Inter Coding: Temporal Prediction With Motion Vectors

For each image (402) in picture N (400), the temporal prediction can often be described by motion vectors that represent the amount of temporal motion required for the image (403) to move to a new temporal position in the picture N (402).  
'374 Patent, 6:25-29

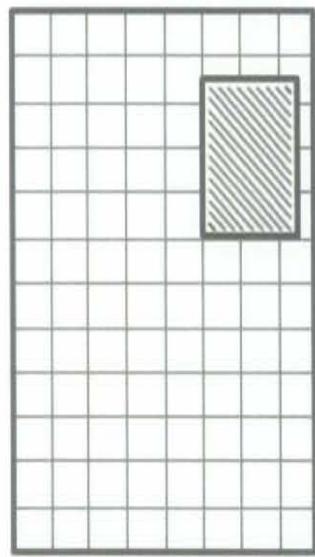


## Inter Coding: Temporal Prediction With Motion Vectors

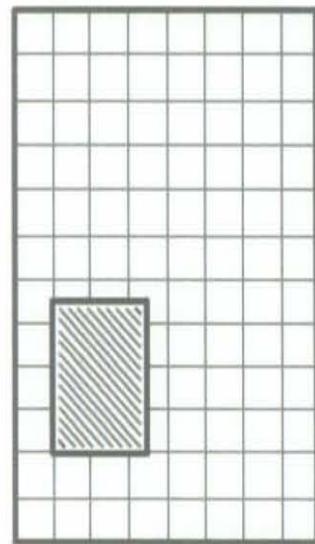


**FIG. 1**

## Inter Coding: Temporal Prediction With Motion Vectors



Predicted Picture



Reference Picture



Index



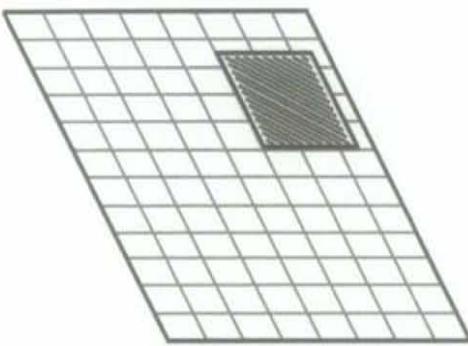
FRAME  
169

SLIDE  
10

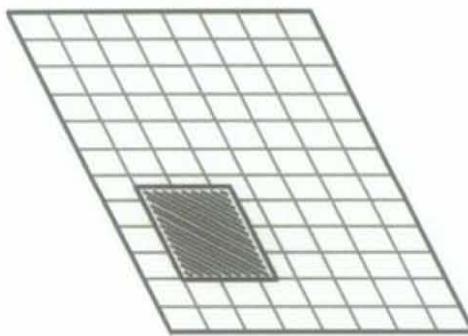


## Inter Coding: Temporal Prediction With Motion Vectors

**Image in Predicted Picture is predicted  
from image in Reference Picture**



Predicted Picture



Reference Picture



Index



FRAME  
210

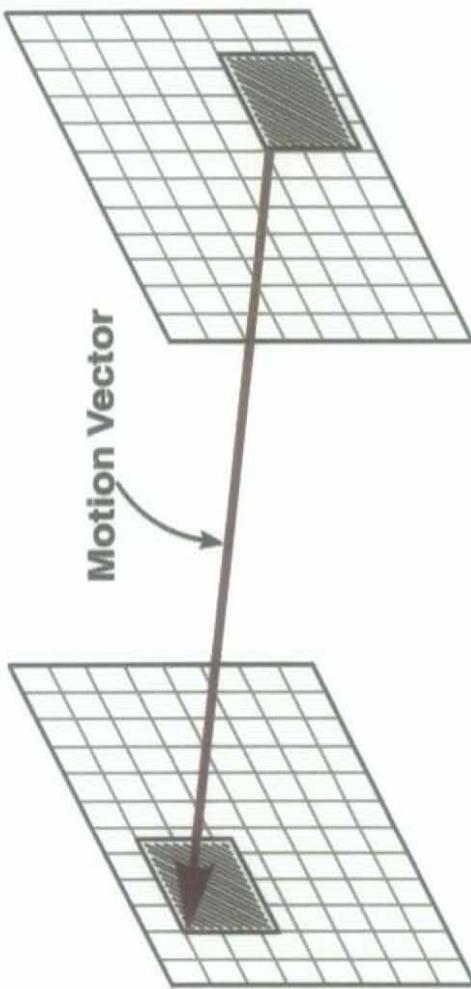
SLIDE  
10

UP

DOWN

## Inter Coding: Temporal Prediction With Motion Vectors

**Motion Vector points to the image  
in the Reference Picture**



Predicted Picture

Reference Picture



Index



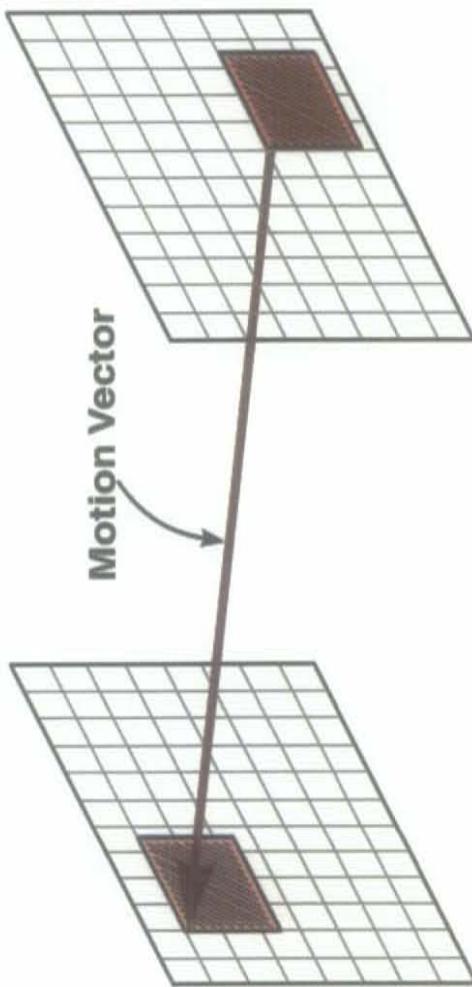
FRAME  
242

SLIDE  
10

↓

## Inter Coding: Temporal Prediction With Motion Vectors

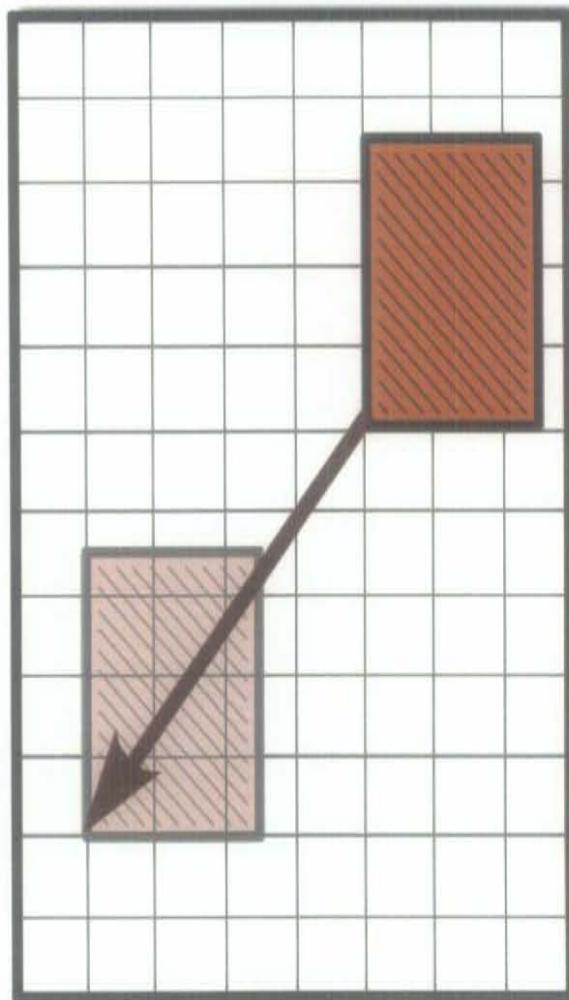
A motion vector is used to predict the image from a corresponding image in the reference picture



Reference Picture      Predicted Picture

## Inter Coding: Temporal Prediction With Motion Vectors

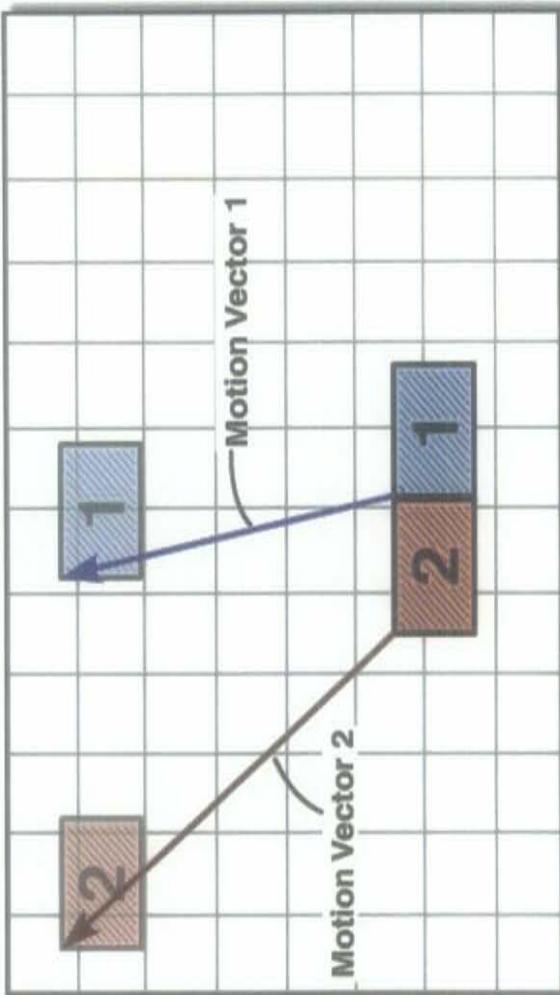
A motion vector is used to predict the image from a corresponding image in the reference picture



## Motion Vectors Can Be Spatially Predictive Coded

The motion vectors are spatially predictive coded.... [I]n inter coding, prediction motion vectors (PMV) are also calculated for each block. The algebraic difference between a block's PMVs and its associated motion vectors is then calculated and encoded. This generates the compressed bits for motion vectors.

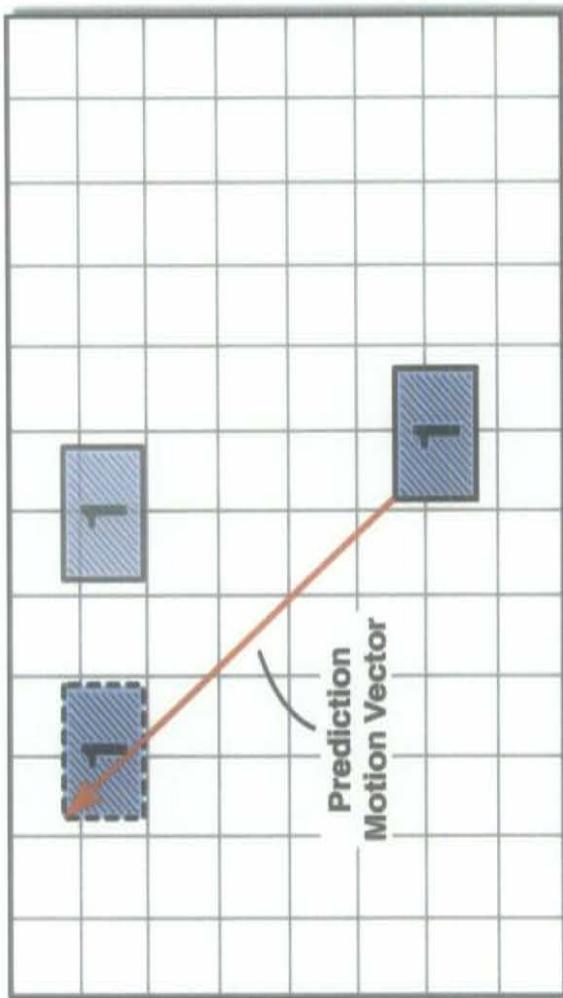
\*374 Patent, 9:39-45



## Motion Vectors Can Be Spatially Predictive Coded

The motion vectors are spatially predictive coded.... [I]n inter coding, prediction motion vectors (PMV) are also calculated for each block. The algebraic difference between a block's PMVs and its associated motion vectors is then calculated and encoded. This generates the compressed bits for motion vectors.

\*374 Patent, 9:39-45



FRAME  
222

SLIDE  
11

DOWN

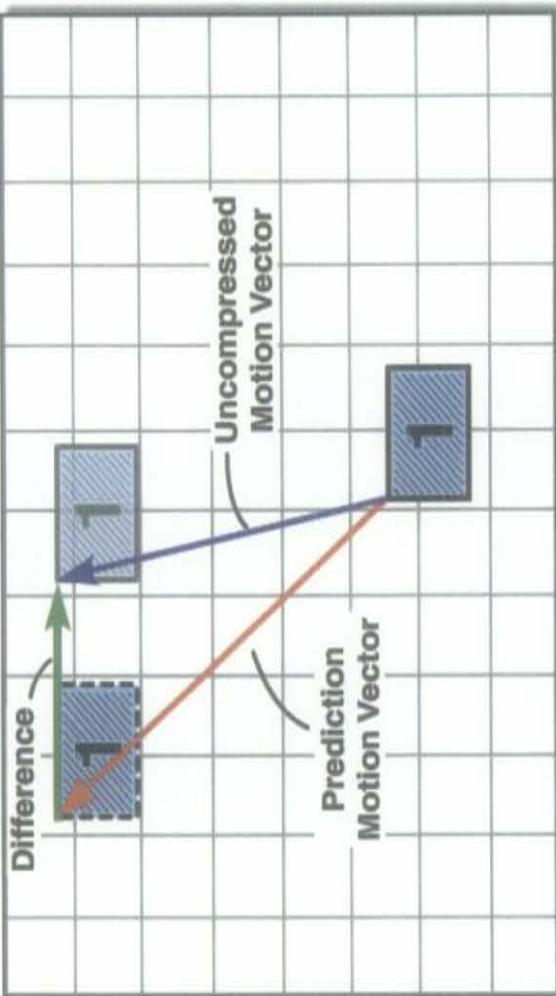
Index

X

## Motion Vectors Can Be Spatially Predictive Coded

The motion vectors are spatially predictive coded.... [I]n inter coding, prediction motion vectors (PMV) are also calculated for each block. The algebraic difference between a block's PMVs and its associated motion vectors is then calculated and encoded. This generates the compressed bits for motion vectors.

\*'374 Patent, 9:39-45



FRAME  
283

SLIDE  
11

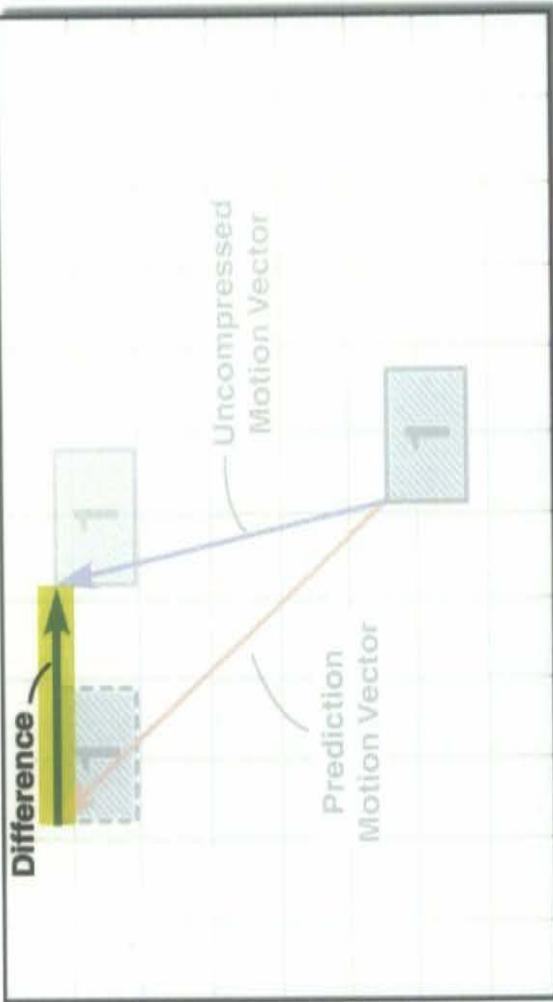
UP  
DOWN

X  
Index

## Motion Vectors Can Be Spatially Predictive Coded

The motion vectors are spatially predictive coded.... [I]n inter coding, prediction motion vectors (PMV) are also calculated for each block. The algebraic difference between a block's PMVs and its associated motion vectors is then calculated and encoded. This generates the compressed bits for motion vectors.

\*'374 Patent, 9:39-45



FRAME  
305

SLIDE  
11

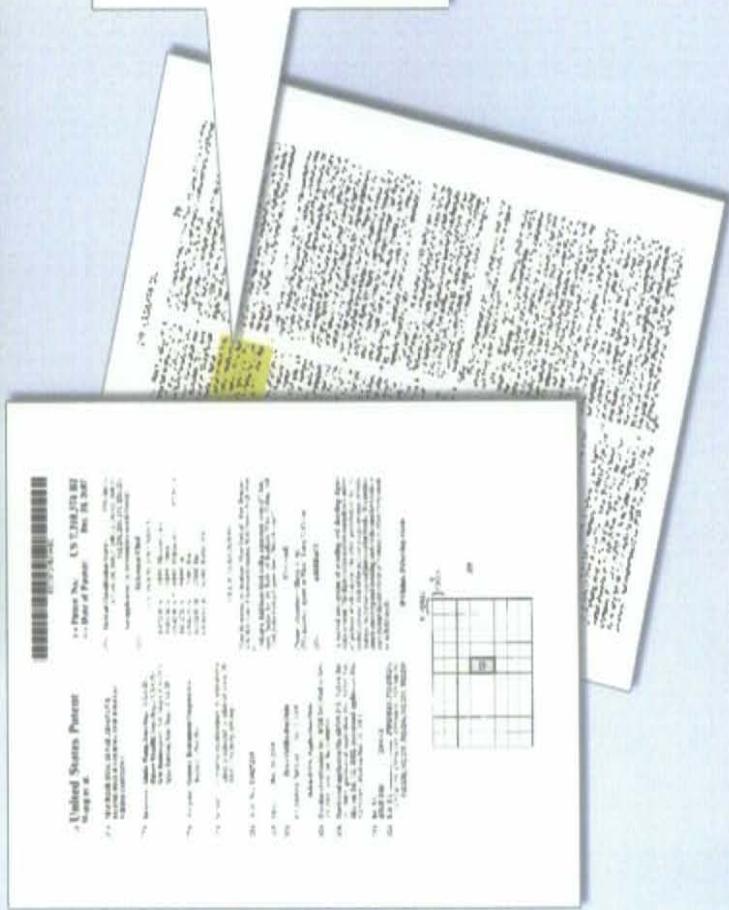
↓

## The '375 Patent Claims Are Directed To The MBAFF Invention Together With Intra Coding

Intra coding is coding a picture without referring to reference pictures (*i.e.*, pictures earlier or later in time) by predicting the values of a block of pixels based on pixels from neighboring blocks within the same picture.

“According to an embodiment of the present invention, each frame and field based macroblock in macroblock level AFF can be *intra coded* or *inter coded*. In intra coding, the macroblock is encoded without temporally referring to other macroblocks.”

\*374 Patent, 9:9-13



## In Intra Coding, A Block Is Coded Using Pixels In Neighboring Blocks

Q A B C D E F G H

	a	b	c	d
I	e	f	g	h
J	i	j	k	l
K	m	n	o	p

M N O P

"For intra<sub>4x4</sub> mode, the *predictions of the pixels* in a 4 by 4 pixel block, as shown in FIG. 14, are derived from its *left and above pixels*. In FIG. 14, the 16 pixels in the 4 by 4 pixel block are labeled a through p. Also shown in FIG. 14 are the neighboring pixels A through P. The neighboring pixels are in capital letters."

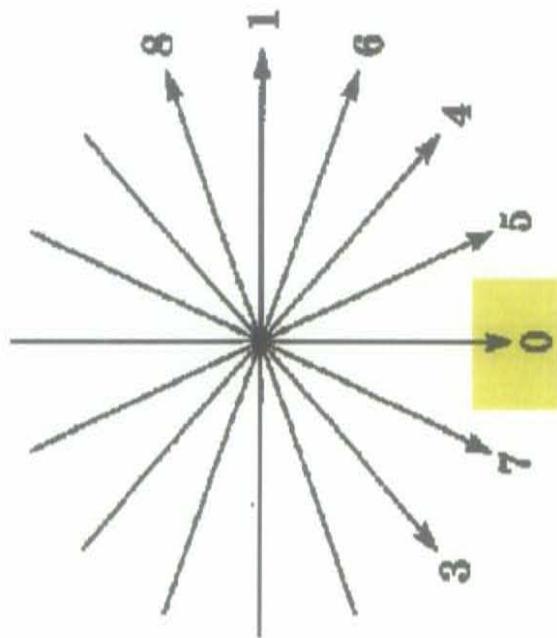
'374 Patent, 14:46-51

**FIG. 14**

## In Intra Coding, A Block Is Coded Using Pixels In Neighboring Blocks

“As shown in FIG. 15, there are **nine different prediction directions** for intra<sub>4x4</sub> coding. They are vertical (0), horizontal (1), DC prediction (mode 2), diagonal down/left (3), diagonal down/right (4), vertical-left (5), horizontal-down (6), vertical-right (7), and horizontal-up (8). DC prediction averages all the neighboring pixels together to predict a particular pixel value.”

’374 Patent, 14:51-57



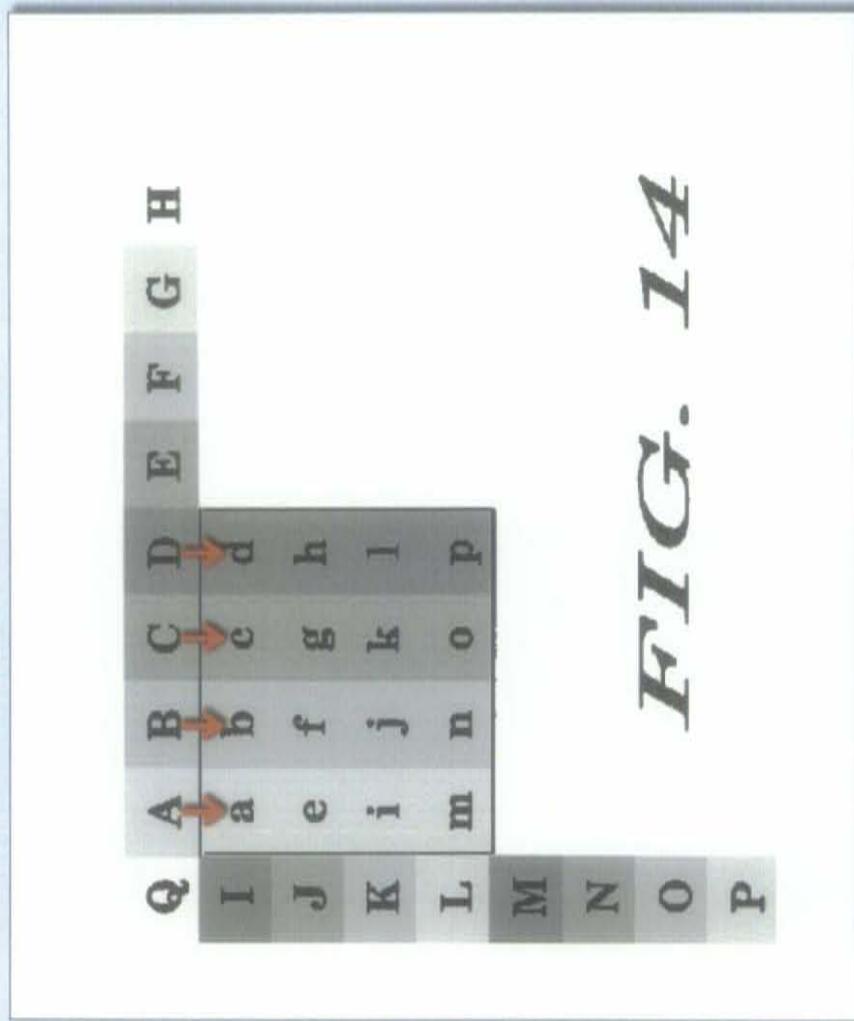
**FIG. 15**

### Intra Coding: VERTICAL Intra Prediction (Mode 0)

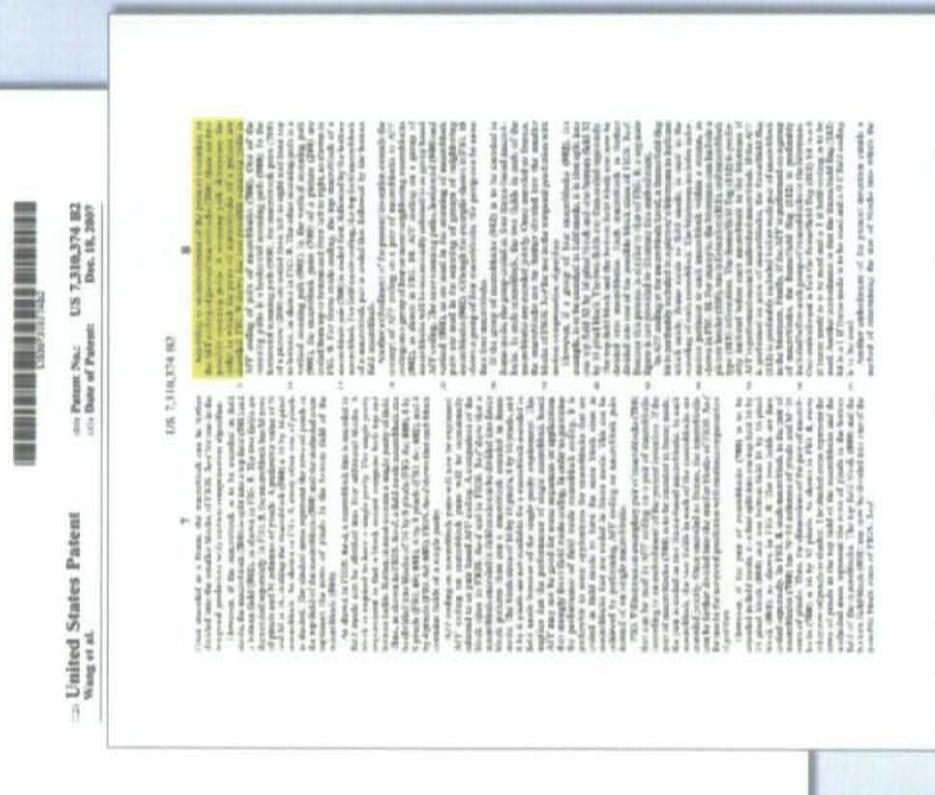
Q	A	B	C	D	E	F	G	H
I	a	b	c	d				
J	e	f	g	h				
K	i	j	k	l				
L	m	n	o	p				
M								
N								
O								
P								

*FIG. 14*

## Intra Coding: VERTICAL Intra Prediction (Mode 0)



## The '376 Patent Claims Are Directed To The MBAFF Invention Together With Scanning Paths



“According to an embodiment of the present invention, in the AFF coding of pairs of macroblocks (700), there are two possible scanning paths. A scanning path determines the order in which the pairs of macroblocks of a picture are encoded.”

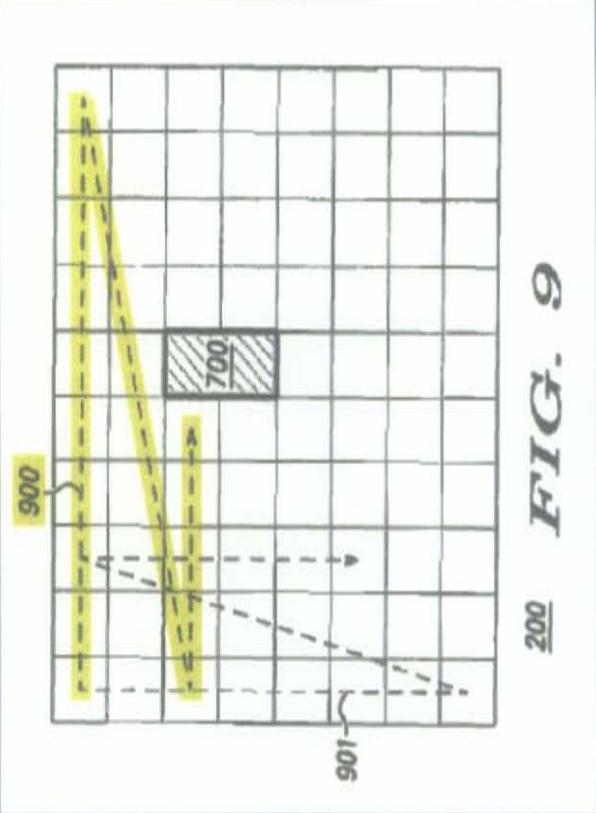
374 Patent, 8:1-5



## Two Possible Scanning Paths: Horizontal And Vertical

"FIG. 9 shows the two possible scanning paths in AFF coding of pairs of macroblocks (700). One of the scanning paths is a horizontal scanning path (900). In the horizontal scanning path (900), the macroblock pairs (700) of a picture (200) are coded from left to right and from top to bottom, as shown in FIG. 9. The other scanning path is a vertical scanning path (901). In the vertical scanning path (901), the macroblock pairs (700) of a picture (200) are coded from top to bottom and from left to right, as shown in FIG. 9."

\*374 Patent, 8:5-14

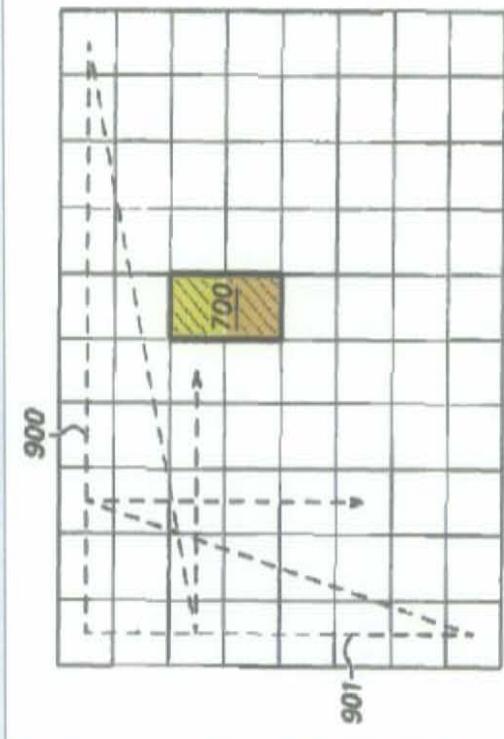


200 FIG. 9

## Horizontal And Vertical Scanning Paths For A Macroblock Pair

"For **frame mode coding**, the top macroblock of a macroblock pair (700) is coded first, followed by the bottom macroblock. For **field mode coding**, the top field macroblock of a macroblock pair is coded first followed by the bottom field macroblock."

'374 Patent, 8:14-18



200 FIG. 9

This concludes the video coding  
technology tutorial submitted by Motorola.